

Claims

- Pub A11
1. A method for providing a simulation of a welding process using integrated models, the integrated models being interconnected by an interconnection tool to determine stresses and distortions of a material being welded, including the steps of:
- determining a model of a geometry of the material;
  - defining a set of coordinates of elements and nodes of the geometry model for a finite element analysis mesh;
  - delivering the finite element analysis mesh coordinates to a thermal analysis model, the thermal analysis model including an analytical solution model and a finite element analysis model;
  - determining a thermal analysis of the welding process as a function of at least one of the analytical solution model and the finite element analysis model, the analytical solution model being adapted to provide a thermal history of the welding process for a global distortion analysis, and the finite element analysis model being adapted to provide a thermal history of the welding process for a detailed residual stress analysis;
  - delivering the thermal history of the welding process to a structural analysis model; and
  - providing a structural analysis of the welding process as a function of the thermal history.

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2. A method, as set forth in claim 1,  
wherein providing a thermal history of the welding  
process for a detailed residual stress analysis  
5 includes the step of providing a thermal history of  
the welding process for a specific portion of the  
welding process.

3. A method, as set forth in claim 1,  
10 wherein providing a structural analysis of the welding  
process includes the step of modeling a set of  
characteristics of the materials being welded during  
the welding process.

4. A method, as set forth in claim 3,  
15 wherein characteristics of the materials include  
residual stresses and distortions.

5. A method, as set forth in claim 1,  
20 wherein determining a thermal analysis of the welding  
process as a function of the analytical solution model  
includes the steps of:

determining a set of adiabatic boundary  
conditions of the material being welded;

25 determining a set of reflected heat sources  
as a function of the adiabatic boundary conditions;

determining a set of point heat sources as a  
function of the reflected heat sources; and

30 determining a total analytical solution from  
superposition of the point heat sources.

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6. A method, as set forth in claim 1,  
wherein determining a thermal analysis of the welding  
process as a function of the finite element analysis  
5 model includes the step of determining a set of  
numerical computations of conditions at each desired  
node and element coordinate of the finite element  
analysis mesh.

10 7. A method, as set forth in claim 1,  
wherein delivering the thermal history of the welding  
process to a structural analysis model includes the  
step of delivering the thermal history by way of an  
interface module.

15 8. An apparatus for providing a simulation  
of a welding process using integrated models, the  
integrated models being interconnected by an  
interconnection tool to determine stresses and  
20 distortions of a material being welded, comprising:

a geometry modeler adapted to determine a  
model of a geometry of the material;

a meshing tool adapted to define a set of  
coordinates of elements and nodes of the geometry  
25 model for a finite element analysis mesh;

a thermal analysis model adapted to receive  
the finite element analysis mesh, determine a thermal  
analysis of the welding process, and responsively  
provide a thermal history of the welding process,  
30 wherein the thermal analysis model includes:

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an analytical solution model adapted to provide a thermal history of the welding process for a global distortion analysis; and

5 a finite element analysis model adapted to provide a thermal history of the welding process for a detailed residual stress analysis; and

a structural analysis model adapted to provide a structural analysis of the welding process as a function of the thermal history.

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9. An apparatus, as set forth in claim 8, wherein the interconnection tool is a graphical user interface.

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